Using the life cycle approach for structuring organizational studies of product chains

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Abstract

Justification: A novel form of life cycle study that focuses on the organization of product chains is presented. The method has been tested in three studies: on a diaper fluff chain (Gullbring & Nilsson 2010), rare earth metal product chains (Eriksson & Olsson 2011), and on a cocoa product chain (Borg & Selmer 2012).

Purpose: Organizational studies on the greening of industry sometimes focus on environmental practices in a single company, a particular sector or phenomenon. To further enrich the methodologies of this field, a novel approach where the life cycle product flow (from the LCA method) is used as a structuring principle for studies of product chain organization is proposed. While an LCA Study is highly technical in content, a product chain organization study does not require much technical knowledge. The mentioned studies were largely empirically conducted by management students. Alternately, an LCA holds much information about industry and society but engineers might not be the best suited to draw conclusions on the management and governance of product chains for industry decision makers and policy makers, which it is necessary to find ways of involving social scientists and management scholar into life cycle studies. The development of an organizational life cycle method for product chain organization studies is just one way of reaching out by attempting to make the life cycle method accessible for them.

The framework: The life cycle, or rather the material flow from raw material extraction to waste management forms a backbone for the organizational study. The organizational study covers the companies, organizations, etc, that enables the material/product to "flow"—without them, no product flow! In the conducted studies, different organizational issues were studied. The method is based in actor—network—theory thinking, which allows for attention to both physical and human actors (cf. Baumann 2004, 2008).

Results: The three studies cover very different topics, ranging from the relation of environmental management in the companies along a particular product chain, to issues of resource security, and the organization of sustainable sourcing.

Conclusions: The three PCO studies show is that the method is viable and versatile, and that it can provide interesting findings, even when no environmental LCA calculation is performed. They also show that it is not necessary to be an engineer to be able to carry out a life cycle study.

Keywords: Life cycle thinking, product chain organisation, method development, case studies, cocoa, rare earth metals.

Acknowledgements

Some people have claimed that the work here presented is academic hodgepodge. In such instances, insecurity gnaws at me. I would therefore like to express my gratitude to all students and PhD students that willingly over the years put my half inarticulated ideas to empirical test. The possibility to 'commute' many years between my home department Environmental Systems Analysis and my second home at the Gothenburg Research Institute, School of Business, Economics and Law, Göteborg University has been invaluable—I direct my gratitude especially to Prof Anne-Marie Tillman at Chalmers and Prof Barbara Czarniawska at GRI. The opportunity to discuss my ideas in general and my Montréal paper in particular in person with Prof Bruno Latour finally settled my doubts.

1. Introduction

A research method is like a scientific instrument—with a new telescope, one can see things one have not seen before. We then have to make sense of what we see. For this, academics apply philosophy of science and develop theories. This paper is not about an entirely new method, but about a few new twists to known methods: LCA as organisation study, or organisation study as a life cycle study. I have chosen to call it Product Chain Organisation study. In hindsight, it may seem like a simple twist, but the process leading up to it has been lengthy. I trace it back to an insight I had more than 10 years ago (cf. Baumann 2004). While I shall not repeat that insight's progression here, I shall attempt to relay some outcomes and justification of my findings.

The work leading up to Product Chain Organisation studies (or PCOs for short) has taken place within a more comprehensive research programme on 'populating' life cycle analysis. The related methodologies that also have come out of it are versions of organisational study in combination with LCA, e.g. LCA nodal point organisation study (Baumann 2004, Brunklaus 2009, Lindkvist & Baumann 2010) and actor-LCA study (Brunklaus, Thormark & Baumann 2010, Baumann et al. 2011). The difference between these methods is the extent to which the techno-environmental analysis and the organisational analysis are focused and emphasized (see figure 1). In addition, the methodology of social-LCA (UNEP-SETAC 2009) has been investigated, resulting in the proposal of an alternative approach after a case study on automotive airbags (Baumann et al. 2012).

One of the main reasons for developing the 'populated' versions of life cycle analysis is that LCA provides insufficient information for discussing circumstances and possibilities for action and the circumstances of the actors in the life cycle. In an LCA, the environmental information is structured according to the technical processes. In the populated LCAs, environmental information (if used) is structured according to the companies, utilities and actors of the life cycle.

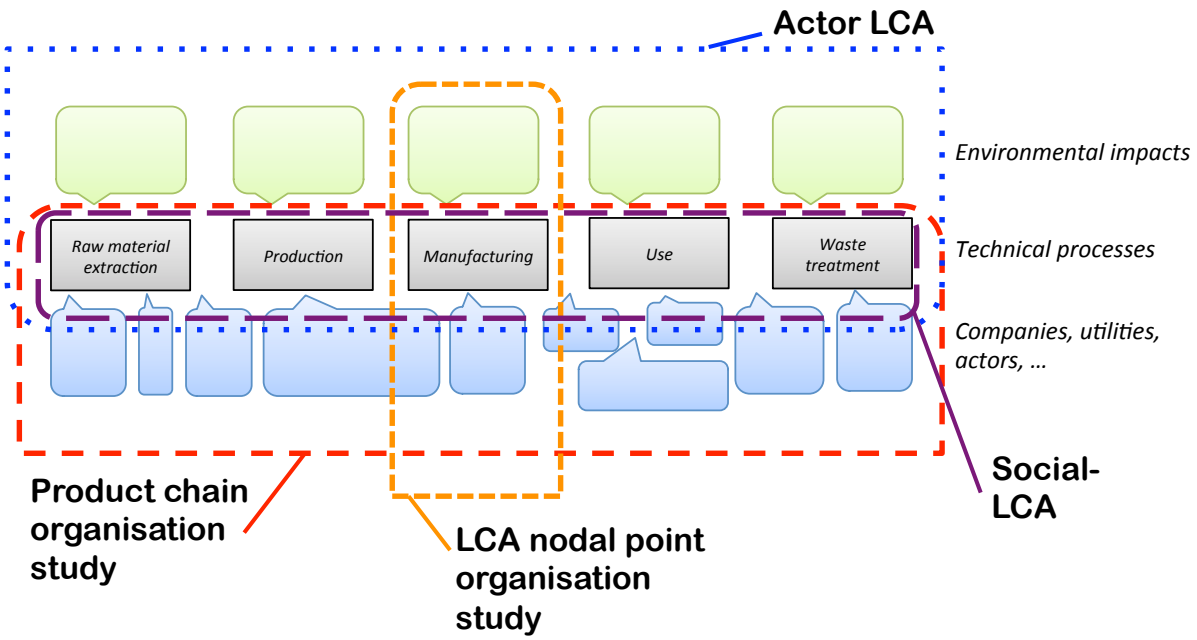

Figure 1. The focus and relationship between the methodologies of populated LCAs.

2. Product chain organisation study - presentation of the method

Whereas many of the populated LCA methods include an environmental analysis of the product chain, product chain organisation study does not. With PCO, the focus is on describing the organisation of the product chain—the organisation of organisations, so to say.

2.1. Material and methods

The method of PCO study has been tested in three empirical studies (see table 1). The scope of the organisation study in a PCO is delineated by the technical 'flow model' (as it is called in an LCA) of the studied product. The organisation study thus covers the chain, or more likely the net of actors that enables the flow of materials from extraction to waste treatment. Depending on the problem at hand, the organisation study may focus on different issues—the PCO studies presented in the following have very different focus.

The PCO study consists of two elements: 1/ drawing up a basic life cycle, i.e. the technical 'flow model', of the studied product, and 2/ doing a study of the organisations and interactions along it. The limited requirement for technical understanding of the product life cycle and the absence of LCA calculations lead to that PCO enable new group of professionals to undertake some form of life cycle study. Calculation skills for an LCA are replaced by skills for doing qualitative and semi-quantitative organisational study in a PCO.

The studies have been carried out by students without special training in LCA methodology. They came from the School of Management of Technology at Chalmers University of Technology and from the School of Business, Economics and Law at Göteborg University. The students were provided with an overall research design and idea (the PCO idea and type of object of study) from me. They then stood for the detailed project design, the empirical work and most of the analysis. I was also their supervisor and examiner.

Table 1. Overview of conducted Product chain organisation studies.

Year	Product	Focus of organisational study	Reference
2010	The fluff in a baby diaper	Investigation of the character of environmental management in a product chain where several companies claimed to be doing Life Cycle Management	Gullbring & Nilsson 2010
2011	Rare earth metals for the electric vehicles	Investigation of the structure of the product chains for critical rare earth metals in order to identify vulnerabilities for secured supply of resources and components	Eriksson & Olsson 2011
2012	Cocoa for Magnum ice cream	Detailed investigation of cocoa sourced in Ghana in order to better understand how traceability of sustainable cocoa can be organised and communicated	Borg & Selmer 2012

Each of the three PCOs has covered the product chain organisation for relatively simple products, for example, for products that are (more or less) single-material components in more complex products, e.g. fluff in a diaper, certain rare earth metals for magnets in electric motors.

Given the global character of industry nowadays, it was important to test the viability of what could possibly turn out to be a very cumbersome organisation study of organisations along a product chain. It was thus decided for the first PCO that the entire product chain should be located within Sweden. The Swedish pulp and paper industry was thus identified, and a company renowned for its longstanding engagement with LCA was approached in order to identify a suitable product (diaper fluff) and its chain for study. Representatives for all actors in the product chain were visited and interviewed. After the first PCO study of a national product chain (Gullbring &Nilsson 2010), the study of a global chain was attempted in the second PCO (Eriksson & Olsson 2011). The global scope of the product chain made a detailed organisational impossible. Instead, structural information about the industry around each technical process (number of actors, location, industrial trends) in the life cycle was collected through desk research (literature, internet, news media, telephone and email). For the third PCO, also on a global product chain, empirical field study in the UK and Ghana is combined with desk research (Borg & Selmer 2012). This allows for better organisational understanding of critical parts of the product chain.

2.2. Theory

For a long period of time, I have been occupied with the problems with LCA and organisation: the notion of 'flow' for inert objects and materials, the technical nature of the analysis involving mainly engineers to draw conclusions on socially relevant issues, management studies limitation to study one organisation (typically equating organisation with a company), the disparate philosophies of knowledge in engineering and management studies and the specialization in the academy that leads to a separation in the study of people and people. With time, small hunches and insights have added to each other so that a more coherent mosaic can be presented. A full account on how all these problems were resolved might be the topic of a publication on its own, but I shall attempt to cover the main arguments.

The problem with 'flow'

Central to any LCA is the modelling of flows from raw material extraction to waste treatment. Unfortunately stuff, matter, components do not flow by themselves—however, that would have been extremely convenient and environmental if they did. Rather they are shipped, transported, conveyed, handled, schlepped, flown, delivered... The concept of 'flow' is misleading by over-simplifying the job that it is to get stuff around the world. And, over-simplification here tends to cloud the complexities of changing the unsustainable movements in production and consumption.

In order to make the 'flow' concept meaningful, it is necessary to also look at the actors, companies, agencies that enable the 'flow' through the handing over of products. I like to use the 'bucket brigade' as a metaphor for the product chain since the bucket brigade is a entity combined of people and stuff for relaying water from one point to another. Without the people there can be no flow of water—without the water, very silly movement of hands. This metaphor also supports a more unified approach to the study of people and matter than the separated approach presently dominating in academia today.

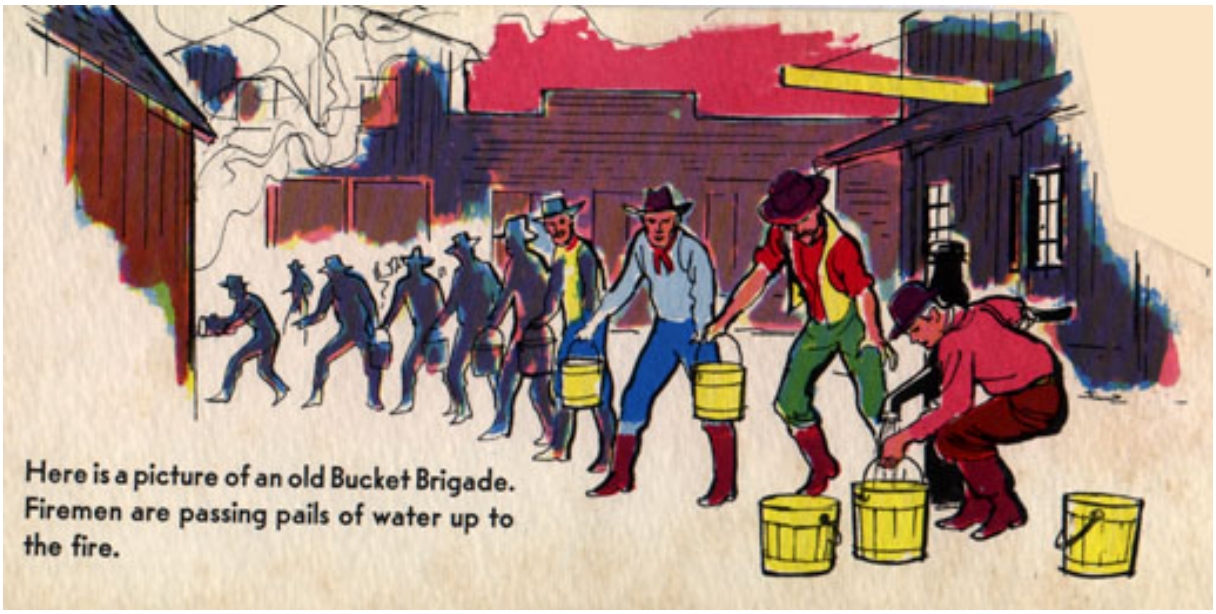

Figure 2. The 'bucket brigade' offers a metaphor that makes sense to 'material flows'.

The problem(s) with 'organisation'

For many the term 'organisation' equates a company. So be it, but 'organisation' is also the substantivation of the verb to organise. The act of organising provides organisation, and this points to a process understanding of organisation. Barbara Czarniawska formulated a simple phrase in which it is easy to distinguish the two uses of organisation: Organisations can be obstacles to organising (Czarniawska 2008). Organisation in its former sense does not sit well with the concept of the product chain since a product chain is made up of a multitude of actors and organisations, so to say. However, in its latter sense, organisation indicates the process of maintaining a product chain. It is a process that involves many organisations in the former sense—an organisation of organisations so to say, or the process of organising organisations. By providing a vocabulary to talk about the organising of various bucket brigade arrangements, it might become easier to talk about the sustainability of product chains. To add to the problem, the disregard to matter in organisational work can lead bizarre arrangements from a material perspective. In my paper "Simple material relations handled by complicated organisation by or ’How many (organisations) does it take to change a lightbulb?’" (Baumann 2008), examples of more or less efficient arrangements are presented. In an absurd example from the operation of grocery retail, around seven organisations were involved for the cleaning up of the entrance from cigarette butts (Lundberg 2006). Thanks to business processes such as outsourcing and focusing on core business, the store manager had to contact the property owner, who in turn contacted the facility company, who in turn contacted a service company, which in turn contact a cleaning company, which in turn contacted a company doing outdoor cleaning... Needless to say (?), the cigarette butts often ended up by being wiped up by the store manager.

The problem with academic specialization and the separation of people and matter

Aligning an LCA study with an organisation study and then treat them as a coherent study requires matching and consistent philosophies of science, especially epistemologically. An ontology that encompasses both people and matter is less of a challenge—people and stuff co-exist everywhere. Their separation is mainly a feat of academic discipline, with its specialised and piecemeal study of the world.

Justification for the combined study of people and matter is twofold: stemming part from Latourian actor—network—theory (e.g. Latour 1993, 1996, 2004), part from digital studies and their object-oriented-ontology (Harman 2002) that opposes anthropocentrism. Bruno Latour claimed (1991/1993) disciplinary differentiation led to the 'Great Divide' and advocated for an equal treatment of stuff and people, or *actants* as he called them. Graham Harman (2011) describes Latour's philosophy well: "...all human and inhuman things, all chunks of physical matter and people and cartoon characters, are equally actors. What makes all things actors, despite the vast differences between them, is that they have an effect on other things. As Latour puts it as recently as 1999 in Pandora's Hope, to be real means 'to modify, transform, perturb, or create' something else. Reality is defined not by what it is, but by what it does. Not everything is equally strong, since the Chinese government affects more things than does a stick figure drawn in the notebook of a Chinese schoolboy, but everything is equally real." An entertaining dissection of Latourian 'flat' ontology is offered in the re-print of a conversation between Bruno Latour and Graham Harman at London School of Economics at the Information Systems department (Latour, Harman & Erdelyi (2011).

An epistemic position that accords LCAs and organisation studies is an interpretive and constructivist philosophy of knowledge. Usually LCA studies are developed adn discussed according to a systems thinking epistemology, but this is not a necessity. Just as words can be interpreted, so can numbers, and by viewing an LCA as a social construction made according certain conventions, the LCA is levelled with the study of organisation.

So, by straddling the Great Divide and levelling LCA with organisation study, population of LCA becomes possible and coherent study of product chain organisation (PCO) becomes intelligible.

3. Results

It was possible to complete each of the PCOs within the approximate time frame for an MSc project. However, the students undertaking these projects were very able, ingenious and enterprising.
The three studies cover very different topics, ranging from the relation of environmental management in the companies along a particular product chain, to issues of resource security, and the organization of sustainable sourcing. Moreover, each PCO study produced interesting or thought-provoking findings that have also caught the eyes of a wider audience.

3.1. First PCO on the fluff product chain

The 2010 PCO on diaper fluff (Gullbring & Nilsson 2010) described a product chain (see figure 2) with two LCM active companies without any communication or interaction with regard the environmental management of the studied product. The LCM active companies were several companies/actors away from the most polluting companies in the product chain and a green procurement strategy would therefore not address the upstream environmental problems. Moreover, the LCM active companies did not communicate with the most pollutant companies upstream in the product chain in any other way. From the study, it became clear that engaging in LCM was mainly an internal activity, for example, in the form of eco-design and internal LCA experts communicating with other departments. In short, LCM in this case did not implicate the fluff product chain, only two separate companies without exchange on the issue. The suggestion (from the two students) that an

LCM active company could communicate its life cycle concern to some of the most polluting companies upstream, even if these were not direct suppliers, was met with disbelief: '...but we cannot do that — that's for regulators to do..!'
Apart from the thesis publication, the study was accepted for presentation at the European Academy of Management conference in Rome 2010.

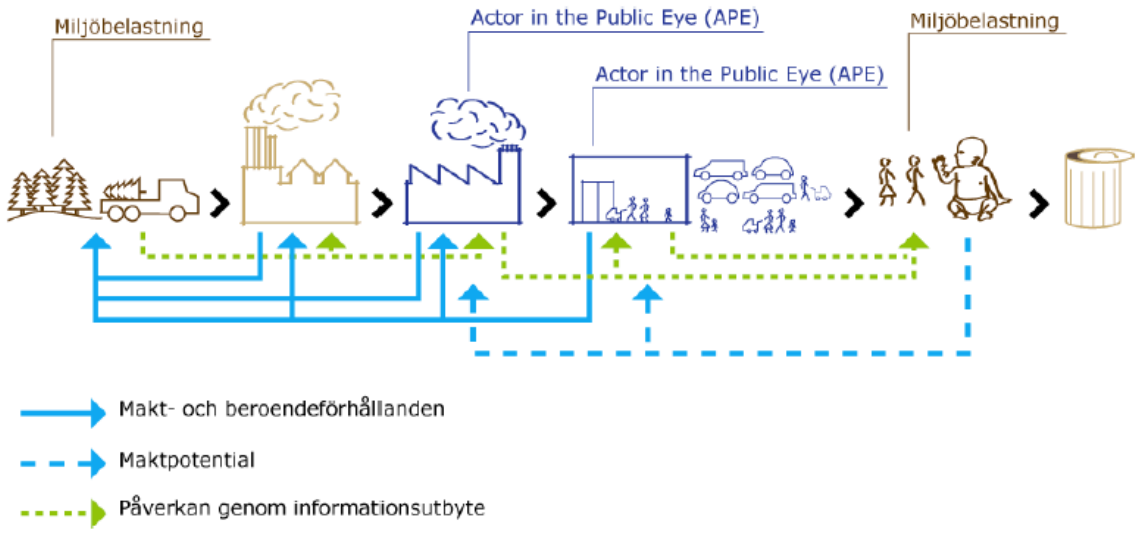

Figure 2. The product chain for diaper fluff in Gullbring & Nilsson (2010). The LCM active companies happened to be the companies in chain that were the most visible to the general public, hence called 'actor in the public eye' in the illustration.

3.2. Second PCO study on rare earth metal products

The global trade of rare earth metals presented more of a methodological challenge to the students undertaking the project. In their report (Eriksson & Olsson 2011), they describe elements of their method (see figure 3). The product chain and the life cycle was given, but in order to go from a small functional unit frequent in LCA to the global production volume of the studied rare earth metals, the students added the notion of material flow analysis. And to allow for the study of organisation and institutions along the life cycle, they referred to commodity chain analysis (a concept from human geography). And to provide some framework for the discussion on technology changes around rare earth metal application, parallels to technology assessment were made. Their figure sums up nicely up important dimensions of PCO and its relationship with other methodologies. However, at the time of their study, the vocabulary for populating LCA was still unsettled, and PCO came in use only afterwards.

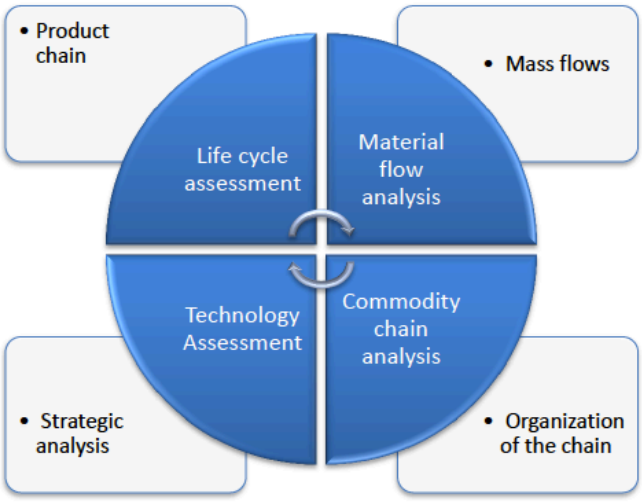

Figure 3. Compound 'PCO' methodology in rare earth metals study by Eriksson & Olsson (2011)

The second study was actually a study of two product chains: that of the rare earth metals for magnets in automotive electric motors, and that of the rare earth metals for batteries in electric vehicles. Parts of the two chains are identical: the first three steps in figure 4.

For each segment of the portrayed product chain, a comprehensive account of the companies (numbers, size and location) and industrial trends (main technologies, on-going change, patents, etc) was given. The starting point of the study was to better understand resource security for these metals, as China's dominant position on the global market was frequently discussed in the news.

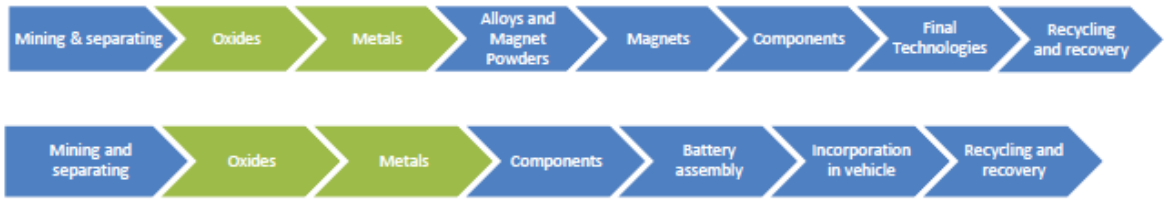

Figure 4. The two studied product chains: rare earth metals for magnets and in batteries (Eriksson & Olsson 2011).

The comprehensive review of the entire product chains revealed what the pointed discussion about China had missed; there were other, significant actors in the chains. For example, rare earth metals are not exclusively found in China, and a host of new mines around the world are going through permitting processes, and the end of Chinese resource dominance is only a matter of time. A particularly important finding with regard to resource security was the fact that a Japanese company holds the world patent for the technology for making permanent neodymium magnets, and the extent of their licensing limits global production volumes (Eriksson & Olsson 2001, p34). I believe that it is the comprehensive view of the product chain that enabled the modified understanding on resource security for the selected rare earth metals. Of course, the issues related to patents and new mines were known in different circles, and they might have become known to a greater public possibly with time. Nevertheless, I would like claim that the methodology offered a sure way to assemble a bigger and

more valid picture for these rare earth metal magnets and batteries. Soon after the MSc students had completed their study, interest in their findings surged from many directions (the Swedish parliament, recycling companies, the Swedish Energy Agency, to name a few). A few months after completion, Therese Eriksson and David Olsson were announced as keynote speakers at the Nordic Energy Outlook conference and they were promoted through the main press release for the event (SEA 2012).

3.3. Third PCO study on cocoa

Although soon completed, this study is still on-going, and for this reason results are not available. The argument for this study is Unilever's pledge to have 100% sustainable chocolate in all Magnum ice creams by 2015. However, Unilever obtains it chocolate from wholesalers and does not have direct contact with cocoa farmers. Unrelated to Unilever, an LCA of cocoa production and processing with Ghanaian beans was found (Ntiamoah & Afrane 2008). Since Ghana is the second largest cocoa producer in the world, contact was made with Dr George Afrane in Ghana in the hope that he would help the MSc students Josefin Borg & Julie K Selmer with contacts in the cocoa industry there. The trip to Ghana was arranged in an attempt to understand the issues related to organising the sourcing of traceable sustainable cocoa. Between May and July 2012, they travelled around Ghana and studied farms, production, research facilities, merchants, NGOs and government agencies related to conventional and sustainable cocoa. As might be expected, Unilever representatives are keenly interested in the study, and extensive dialogue with R&D representatives at Unilever has taken place both before and after the trip. More surprisingly, also UN bodies are looking ways to employ the study (ref needed).
Like the second PCO, this third study describes two product chain organisations, here, conventional cocoa and sustainable cocoa. The difference between this and the former study is that the two cocoa chains are described for sake of comparison. How the methodology measures up in this comparison is still unclear.

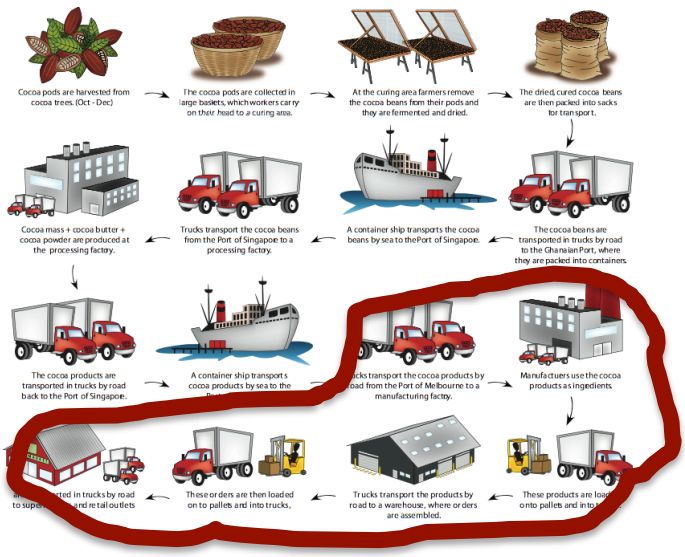

Figure 5. Illustration of the chocolate product chain. Parts circled in red represent approximately the extent of the chain under Unilever's present sphere of agency.

4. Discussion

From a methodological point of view, PCO defends its existence by its alternative research approach to study product life cycles. From a theoretical point of view, PCO study need to deliver meaningful findings to those fields of inquiry it is being applied. The verdict on the contribution of PCO study rests with its future uptake and application. However, after three studies on very different products and topics, my own view is that PCO study has been unexpectedly successful. While I initially feared that students would get lost in huge and impractical exploration, drowning in an excess of data, none of them did. Empirical projects have shown that study of PCOs is viable and useful, even if some caution needs to be mentioned: some product chains may be too large to handle in research. Nevertheless, experience from the three PCOs so far is that organisation study structured by a life cycle perspective helps produce rounded descriptions of product chain complexities in some novel way—expressed interest in the studies point to this.
The long gestation time—more than 12 years from first impulse to empirical tests and publication—has been filled with pondering the scientific philosophy and consistency for these types of study. It is not until now that I feel I have a sufficiently coherent and convincing argument. Yet I suspect that the concluding test of PCO study is probably made through useful application rather than through philosophical discussion. The acid test of the PCO approach is its uptake by other scholars.

5. Contribution of PCOs

Not only do I try to populate LCA, I would also like to involve more social scientists in these kinds of studies. Most LCA studies contain much information about industry, society and their environmental consequences. The technical nature of LCA puts such analysis mainly in the hands of engineers. Engineers' ability to make flow models and calculations need not challenging, but I doubt their expertise when it comes to discuss and develop ways forward for management and governance. A method such as PCO is hopefully more accessible for social and management scholars than is LCA. Possibly this would add new issues and perspectives to life cycle management and product chain governance.

References

Baumann, Henrikke (2004). Environmental assessment of organising: towards a framework for the study of organisational influence on environmental performance. *Progress in Industrial Ecology*, 1(1-3): 292-306.

Baumann, Henrikke (2008). Simple Material relations Handled by Complicated organization By or 'How many (organisations) Does it Take to Change a lightbulb?' In proceedings of *What is an organization? Materiality, Agency And Discourse*, May 21-22, 2008, HEC Montréal, Université de Montréal, Québec, Canada.

Baumann, Henrikke, Johanna Berlin, Birgit Brunklaus, Mathias Lindkvist, Birger Löfgren & Anne-Marie Tillman (2011). The Usefulness of an Actor's Perspective in LCA. In *Towards Life Cycle Sustainability Management* (ed M Finkbeiner), part 2, pp 73-83. Springer Verlag, Berlin.

Baumann, Henrikke, Rickard Arvidsson, Hui Tong & Jing Wang (2012). Does the production of an airbag injure more people than the airbag saves in traffic? Opting for an empirically-based approach to S-LCA methodology. *Journal of Industrial Ecology* (forthcoming).

Borg, Josefin & Julie K Selmer (2012). *Organizing traceable sustainable Cocoa supplies—a study of the organization of a cocoa chain From Ghana To Unilever*. ESA report 2012:X, Chalmers University of Technology, Göteborg. In progress.

Brunklaus, Birgit (2009). Does organising matter? Tracing connections to environmental impacts in different housing estates. *Progress in Industrial Ecology*, 6(2): 120-134.

Brunklaus, Birgit, Catarina Thormark & Henrikke Baumann (2010). Illustrating limitations of energy studies of buildings with LCA and actor analysis. Building Research & Information, 38(3): 265-279.

Eriksson, Therese & David Olsson (2011). *The Product Chains of Rare Earth Elements Used in Permanent Magnets and NiMH Batteries for Electric Vehicles*. ESA report 2011:8, Chalmers University of Technology, Göteborg.

Gullbring, AnnSofie & Hanna Nilsson (2010). *Fluffets väg – Miljömanagement i en produktkedja*. C-uppsats, Management 2010:20, School of Business, Economics and Law, Göteborg University. (The way of the Fluff—Environmental management in a product chain)

Harman, Graham (2002). *Tool-Being: Heidegger and the Metaphysics of Objects*. Open Court Publishing, Chicago, Ill, US.

Harman, Graham (2011). The road to objects. *continent*, 3(1):171-179 .

Latour, Bruno (1993). *We have never been modern* (tr. by Catherine Porter). Harvard University Press, Cambridge, MA, US. (Orginal version in French in 1991).

Latour, Bruno (1996). *Aramis, or the love of technology*, Harvard University Press, Cambridge, MA, USA. (Orginal version in French in 1992).

Latour, Bruno (2004). *Politics of Nature: How to Bring the Sciences into Democracy* (tr. by Catherine Porter). Harvard University Press, Cambridge, MA, USA. (Orginal version in French in 1999).

Latour, Bruno, Graham Harman & Peter Erdelyi (2011). *The Prince and the Wolf: Latour and Harman at the LSE*. Zero Books, Alresford, Hants, UK.

Lindkvist, Mathias & Henrikke Baumann (2010). The environmental significance of management practices: Exploring the eco-efficiency of 6 cases. In *Proceedings of the ERSCP-EMSU conference*, Delft, The Netherlands, October 25-29, 2010 (http://www.erscp-emsu2010.org/).

Lundberg, Örjan (2006). *The Commercial Property Sector and the Environment*. ESA report 2006:9, Environmental Systems Analysis, Chalmers University of Technology, Göteborg.

Ntiamoah, Augustine & George Afrane (2008). Environmental impacts of cocoa production and processing in Ghana: life cycle assessment approach. *Journal of Cleaner Production*, 16(16): 1735-1740.

SEA (2012). *Energimarknaden debatteras på Energiutblick.* Swedish Energy Agency, press release, 2012-02-21 (http://energimyndigheten.se/sv/Press/Pressmeddelanden/Energimarknaden-debatteras-pa-Energiutblick/)

UNEP-SETAC (2009). *Guidelines for social life cycle assessment of products*. The UNEP-SETAC LifeCycleInitiative, UNEP, Paris (www.unep.fr).